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FARMERS' BULLETIN 1004  
UNITED STATES DEPARTMENT OF AGRICULTURE

THE  
GAS  
TRACTOR  
IN  
EASTERN  
FARMING



TRACTORS using gasoline or kerosene are increasing in numbers on eastern farms. More than 250 New York State farmers furnished detailed reports of their experience with tractors during 1917 and the spring of 1918, and on these the information given in this bulletin is based.

Both the advantages and the disadvantages of the tractor are pointed out.

The farm conditions under which the tractor has proved successful are given, as to acreages and crops grown.

Work ordinarily may not be done more cheaply with the tractor, but can be done more rapidly.

As general conditions are similar in much of New England and the other Northeastern States, these experiences should prove of interest and value to a large number of farmers in this region.

Not every farmer would find a tractor profitable. First cost is high, it requires proper care and handling, and it must do considerable work to make it worth while.

The experiences summarized in these pages should help every farmer to decide whether a tractor will prove profitable to him.

## Office of the Secretary

#### Contribution from the Office of Farm Management

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Washington, D. C.

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# THE GAS TRACTOR IN EASTERN FARMING

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## THE TRACTOR GAINING FAVOR IN THE EAST.

THE EARLIEST USE of the gas tractor for farming purposes in this country was in the Northwest and Middle West. During the past two or three years, however, these machines have been used in constantly increasing numbers on eastern farms. The information contained herein is derived from detailed reports received from over 250 experienced tractor owners in New York State during 1917 and the spring of 1918. The aim is to present what are considered to be, from the farmer's standpoint, the most important facts and figures reported by these men. General conditions in New York are such as to make the experience of these men of value to farmers who are considering the purchase of tractors for use on farms in any of the Northeastern States. From a comparison of New York reports with numerous reports from other Eastern States, it is believed that the New York farms on which tractors were found are fairly typical of most of the farms in these States on which tractors have already been bought, or for which such purchase would be seriously considered.

The general conditions under which the tractors reported by New York farmers have worked are as follows:

Surface, for the greater part, rolling; soil, a comparatively heavy loam, with heavy clay subsoil, small stones very plentiful and larger ones quite numerous in many cases. The latter range in size from those which will roll out when the plow hits them, to fixed rocks which will cause a breakage of plow or hitch, or a sprung beam unless a wooden break-pin or a sprung trip is used.

## WHAT FARMS USE TRACTORS.

In considering the results which have been obtained with the tractor on any farm or group of farms, it is, of course, essential that the kind of farming be taken into account.

The farms on which tractors have been used in New York are very diversified. On practically all, at least half a dozen different field crops are grown, while on many farms eight or nine are found. The table below shows the principal crops grown, the percentage of farms on which each was raised, the approximate acreage of each crop for an imaginary farm of 165 crop acres, and the percentage of the crop acreage devoted to each crop. Of course, few, if any, farms actually raised all the crops shown, but the table gives a fair idea of the kind of farming followed.

*Crops grown on typical New York farms where tractors are used.*

Crop.	Percentage of farms growing.	Acres in each crop, based on percentage shown, and 165 crop acres per farm.	Percentage of crop acres reported in each crop.
Hay.....	98	64	39
Oats.....	92	23	14
Wheat.....	80	25	15
Corn.....	92	18	11
Barley.....	48	7	4
Beans.....	26	7	4
Rye.....	26	5	3
Potatoes.....	40	3	2
Orchard.....	17	5	3
Buckwheat.....	15	1	1
Miscellaneous.....		7	4

The miscellaneous crops include principally cabbage, tomatoes, peas, carrots, and other vegetables. On a few farms there is a small amount of tillable pasture, which, since it is not strictly a crop and is comparatively unimportant, has not been included.

A small percentage of tractors in New York have been used on farms where more than 40 per cent of the crop acreage was devoted to fruit. These represent only about one-tenth of the tractors, however, and inasmuch as this kind of farming was very dissimilar to that found on a majority of the farms where tractors were used, the records from these fruit farms have not been included in any of the calculations in this bulletin.

The facts relative to the kind of farming followed should be kept in mind in considering the points brought out in the following pages. The fact that more than one-third of the entire crop acreage on practically all of the farms is devoted to hay is particularly important, since most tractors are used little, if any, in connection with the hay crop. Where used their work is usually limited to pulling

wagons where hay loaders are used, but even this is not common. The diversity of crops raised in most cases reduces to a comparatively small amount the plowing which must be done annually. This obviously accounts for the fact that a tractor of a given size will prove ample under such conditions for a larger farm than would be the case where only two or three crops are grown, such as the Corn Belt farms, where a greater percentage of the farm acreage is plowed each year.

It should be clearly understood that the figures contained herein represent average results obtained in actual service and not the maximum possibilities of the tractor. These averages are worth more to a farmer in determining the possible value of a tractor for his work than are maximum figures from tests, no matter how carefully conducted. A prospective purchaser may reasonably count upon equaling the average performance of his neighbor. He should strive, of course, to equal the maximum performance of experts, but should not depend upon being able to accomplish such results in order to justify investing in a tractor. For example, an outfit with sharp, new plows, operated by an expert, may plow an acre of ground with, say, 2 gallons of gasoline, but since, under ordinary conditions, with plows that have been sharpened several times and perhaps are not in perfect adjustment, the fuel consumption will ordinarily equal at least the average given herein (about  $3\frac{1}{2}$  gallons), it is obvious that the farmer should use the average figure in determining the possible value of the tractor for his work, rather than the exceptional figure.

The question whether a tractor will prove profitable on any particular farm is a problem in farm management which must be worked out for that individual farm. Judging by the reports of owners, however, it will prove profitable on a large percentage of eastern farms of comparatively large size, but should not be expected to do so on farms of much less than 120 acres.

#### ADVANTAGES AND DISADVANTAGES OF THE TRACTOR.

The important thing for the prospective purchaser of a tractor to know is what the men who have used tractors have found to be their principal advantages and disadvantages in actual practice.

Tractor owners whose reports have been used in preparing this bulletin were asked the questions: "What do you find to be the principal advantages of a tractor for farm work?" and "What are the principal disadvantages?" A summary of these questions showed that the following points were most emphasized:

*Works more rapidly.*—The greatest advantage of the tractor lies in its ability to perform the work in a shorter time than when horses are employed. This point was mentioned by about 50 per cent of the owners. In New York by far the greater part of the plowing is

ordinarily done with walking plows. Even the 2-plow tractor (fig. 1), therefore, results in a considerable increase in the rate of plowing.

*Saves man labor.*—The saving in man labor was next in importance, as would naturally be expected, as this is the logical result of using a machine which will permit one man to do work faster than with the outfits previously used.



FIG. 1.—The 2-plow tractor effects a considerable increase in rate of plowing over the horse-drawn walking plow, but has proved too small to give the best results on many eastern farms.

*Does better work.*—The ability to do better work in plowing and preparing the soil is placed third. While economy, power available for belt work, and work in hot weather were given about the same emphasis they were mentioned by only a small percentage of the tractor owners. In regions where considerable plowing must be done in hot weather, the last mentioned advantage is of marked importance, which illustrates how the value of the tractor varies according to local conditions.

Under disadvantages, the inability to use the tractor satisfactorily until the top soil of the entire field is well dried out was mentioned by about 50 per cent of the farmers.

*Packs moist soil.*—On the comparatively heavy soil in New York packing will frequently be injurious in low spots when most of the field is fit to work, and there is considerable likelihood of the tractor miring in such places.

*Inefficient operators.*—Next to this feature is the difficulty of obtaining an efficient operator. This is by no means confined to New York or the East, but is generally true wherever tractors are used; it is more fully discussed under "The tractor operator," on page 23.

*Breakdowns.*—Delays from breakdowns came third in importance, but this is often due to inefficient operation.

*Unsatisfactory on rough land.*—Unsatisfactory work on hilly and rough land, especially in stony fields, is frequently mentioned. The presence of these features on a farm should therefore be given careful consideration before buying a tractor.

*Unsuitable for small fields.*—Expense in operation was occasionally mentioned, while unsatisfactory operation in small and irregular fields was referred to in a few cases. Such difficulties, however, can usually be overcome by the rearrangement of fields, removal of fences, and following a proper system of laying out the lands for plowing under these conditions.

*Lack of power* was mentioned by a few men, but this can scarcely be classed as a disadvantage of the tractor, as it is usually the result of error in choosing a machine too small for the work required of it. This point is important, and is more fully covered under the next heading.

#### SIZE OF FARM AND TRACTOR.

Though the use of a tractor may be expected to reduce the man labor required for farm operations, thus permitting one man to accomplish more work and so farm more land than with horses, it is obvious that a farm business must be of sufficient size to permit its economical use in order to justify the necessary investment. That is, many small farms must either use the old methods or hire a tractor because the small amount of work to be done each year does not warrant owning it.

Among the more important facts disclosed by a study of the use of the tractor for farm work are those relating to the increase in the acreage which can be farmed by one man when a tractor is used in connection with horses over that farmed with horses alone. Eighty-four per cent of these New York tractor owners say that the tractor has proved a profitable investment to them. Of this number a little over one-third, after purchasing the machine, increased the acreage

they were farming. On the other hand, of the men who found the tractor unprofitable, only one-tenth increased their acreage after purchase of the tractor.

This comparatively high percentage of the entire number of tractor owners who have enlarged their farms is significant, for whereas there has been a tendency for the size of general farms to increase in recent years<sup>1</sup> owing to the influence of improved farm equipment, this increase in general is not nearly so pronounced as on farms where tractors are used.

With the tractor, as with any other farm machine, it is important that a suitable size should be selected for a given acreage.<sup>2</sup> By far the larger part of the tractors sold at this time pull either 2, 3, or 4 plows, with the 3-plow size the most numerous, taking the country as a whole. In the State of New York, judging by the reports received from tractor owners, the number of 3-plow machines sold in 1916 was slightly less than one-third of the total number of 2-plow outfits sold in that State. In 1917, however, the 3-plow machines amounted to about two-thirds of the number of the 2-plow rigs. It is evident that the 2-plow tractor has shown itself to be too small for efficient work on many New York farms where it has been purchased, as is indicated by the fact that out of 237 owners 118 say that the 3-plow outfits are more suitable for their farms, while only 110 recommend the 2-plow size; nine men stated that 4-plow tractors would be the best for them, whereas more than two-thirds of the entire number of owners had originally bought 2-plow outfits. This is a very important point for a farmer who is contemplating purchasing a tractor.

While the 2-plow machine is recommended by a majority of owners of farms of 150 or fewer crop acres as being most suitable for farms of that size, even a considerable percentage of these men recommend the 3-plow machines. This, taken with other facts, leads to the conclusion that, in general, the 2-plow tractor does not increase sufficiently the amount of work which one man can do, hence does not possess, in an adequate degree, the greatest advantage of tractors in general, namely, timeliness in performing farm operations through much more rapid work than is possible with horses. Moreover, a 2-plow tractor does not ordinarily develop enough power to make it suitable for operating separators, large ensilage cutters, etc., which are tasks for which power is required on many eastern farms. It happens not infrequently that the owner of a 2-plow tractor has to hire an engine with slightly more power to do his belt work, so it is not to be wondered at that in case he was buying another machine

<sup>1</sup> U. S. Census, 1910, Vol. V, Chapter V.

<sup>2</sup> In all cases the size of tractor is referred to by the number of 14-inch plows pulled rather than by the horsepower ratings. This is done because manufacturers do not use a uniform method of rating their outfits, and a comparison of different tractors by their horsepower ratings is practically valueless.

he would select one with more power. The 3-plow tractor is distinctly the favorite among owners of farms containing 151 or more crop acres.

An important point in this connection is the fact that it is exceedingly difficult to keep a gas tractor in such condition that it will develop a high percentage of its rated power at all times, since wear in different parts, imperfect adjustment, etc., may greatly reduce the amount of power it will develop. Hence, a machine which will develop adequate power to meet requirements when new and in perfect order, may prove very unsatisfactory for both field and belt work after having been used a short time.

Another point is that soil conditions in the eastern part of the United States are such as to require considerably more power to do the work of plowing than in most of the Middle West and western sections. This difference is so great that many machines which pull three plows in sections where plowing is comparatively easy, can pull only two plows under eastern conditions.

#### COST OF TRACTOR OUTFIT.

While the cost of a tractor should not be the only consideration, it is one of the points which a farmer must consider. The prices of the different makes of outfits vary considerably for machines of practically the same capacity, owing to difference in quality, sales systems, efficiency in manufacture, and quantity produced. It is a grave mistake to sacrifice quality for a saving in the first cost, since in no other farm machine does reliability and serviceability count for more than in the tractor. On the other hand, it is poor management for a farmer to invest too large a part of his capital in power.

The price which a farmer can afford to pay for a tractor for use on his farm depends upon (1) the amount and value of the work which the machine will perform annually, (2) the value of the horses which it will displace, (3) the value of the man labor saved, and (4) the amount of increased returns which reasonably may be expected from its use.

The prices paid for the two sizes most commonly bought during 1917 on the New York farms reporting, averaged about \$775 for the 2-plow, and \$1,050 for the 3-plow machine, while the prices for the plows for use with them averaged about \$120 and \$145, respectively. In all cases the prices, of course, varied considerably according to the make and quality of the machines. At the beginning of 1918 there was a further general and substantial increase in prices.

#### LIFE OF THE TRACTOR.

Several factors have considerable influence on the amount of service rendered by a given tractor, by far the most important of which

is the care it receives at the hands of the operator. (See "The tractor operator," p. 23.) The quality of the outfit, the kinds of work for which it is used, and the conditions under which it is operated all materially affect its life.

Tractors travel over rough and uneven ground, and are subjected to severe shocks, both from obstructions in the path and from the load being pulled. They are exposed to an almost constant shower of dust and dirt which attacks all gears and bearing surfaces, even inside the engine itself, unless an efficient filter is provided for the air intake to the carburetor. This excessive wear, owing to dust, was a very serious matter with the earlier models of tractors, but many manufacturers have made great progress during the last year or two in protecting their machines in this respect.

It is obviously impossible to determine definitely the probable life of the latest model tractors, since none of them is worn out. Tractor owners were asked for an opinion as to the number of years their own particular machines would give satisfactory service, and also to give an estimate of the average life of farm tractors. The replies to these questions showed a tendency on the part of men who reported the tractor as having been profitable to estimate that their own machines would last somewhat longer than the average machine. On the other hand, men reporting them unprofitable usually gave the probable life of their machines as less than their estimate of the average life of tractors in general. The answers the men gave to both questions, however, averaged very nearly the same, being 9 years for their own machines, and  $8\frac{1}{2}$  years for all tractors.

It is interesting to note that the average of the estimates for the years of service they expected to obtain from their tractors on the part of tractor owners who reported that their machines had proved a profitable investment was  $9\frac{1}{2}$  years, while men who reported that their machines had proved unprofitable investments gave an average of  $5\frac{3}{4}$  years of service. In a considerable percentage of cases where tractors have proved unprofitable, inefficient operation has largely contributed to their failure.

Of course, the averages here given can not be regarded as being absolutely accurate, but they should be as nearly so as any figures which could be obtained in any other manner at the present time. As a matter of fact there would probably be a tendency on the part of tractor owners to overestimate somewhat. (See "Repairs," p. 12.) It is not believed, however, that a prospective purchaser of a tractor should expect for his outfit a longer life than  $8\frac{1}{2}$  seasons (the average estimated life of tractors by tractor owners), and he would be on the safe side if he counted on a somewhat shorter period of service when calculating the probable value of a tractor for his work.

## DAYS USED ANNUALLY.

The number of years a tractor will last will depend partly upon the amount of work done each year; that is, the number of days or hours it is used. This varies on different farms as noted above.

Farm tractors in New York are used an average of 54 days annually, including both home and custom work. On farms of 100 crop acres or fewer (average 81), the average days used on the home farm was about 33, while on farms of 151 to 250 crop acres (average 193), the outfits were used on the home farm 47 days, notwithstanding the fact that the machines used on the larger farms averaged larger in size than those on the smaller farms. At the same time tractors on the smaller farms were used considerably more for custom work than were the outfits on the larger farms mentioned.

While at first glance these figures may appear low, when it is remembered that on farms where horses do all the work they are used on an average of only about 100 days annually, it will be seen that where both horses and tractor are used, even though the number of horses is somewhat reduced, the machine need not be expected to have employment for as many days annually as did the horses. The horses kept will still do some of the work, which, of course, will reduce the amount to be done by the tractor. A considerable percentage of the 100 days' work done by horses represents odd jobs for which the tractor can not be used to advantage. Even if the machine were to do all the work formerly done by the horses, it would not normally be employed 100 days per year, inasmuch as it does the work more rapidly than horses.

It should be borne in mind that practically all farm operations must be carried on within limited periods, and that between these seasons there will often be no field work which the tractor can do, either on the home farm or for neighbors. The fact that weather and soil conditions are such as to permit field work with a tractor does not necessarily mean that there is such work to be done. Farm management plays an important part in organizing the farm so as to provide profitable employment for the tractor during as many days as possible. Such organization involves the planning of a crop rotation which will furnish a large amount of work which it can do, the elimination of as many horses as practicable, and the distribution of the work over a long period. However, the rotation should include only such crops as can be grown profitably in that particular region.

The significance of the fact that a large percentage of these New York farmers enlarged their farms after buying tractors is readily apparent when the tractor's place in farm management is thus considered. Obviously these men have learned through experience that

much more land per man can be handled when a tractor is used than with horses only, and that to get the most out of their investment they must farm land enough to keep their tractors busy at profitable work throughout as much as possible of the available working season.

#### TRACTOR REPAIRS.

The extent of repairs required depends upon (1) the proficiency of the operator and the care he gives the outfit, both when in use and when idle, (2) the conditions under which the outfit is used, (3) the load it is required to pull, and (4) the quality of the machine itself. Many tractors are kept in repair by the manufacturer during the first year's service, excepting for such items as are caused by some fault of the operator. It is not until the second year, therefore, that the owner bears the full expense. Of 86 tractor owners in New York who had used their outfits one season or less (average age 9 months), 31 reported that they had spent nothing for repairs. The others had repair bills varying from a few cents to \$100, the average being \$17, making the average repairs for the entire group about \$11. Comparatively few machines go through their second season without repair charges. The average repairs for 102 New York outfits between the ages of 13 and 24 months (average age 18 months) was \$34. For 30 machines between the ages of 25 and 36 months (average age 30 months), the average repairs amounted to \$101.

These machines were almost exclusively 2 and 3 plow outfits. The repairs were somewhat heavier for the 3-plow than for the 2-plow machines, but the larger machines also averaged more days' use annually, since they were generally on the larger farms.

The statement is frequently made that a tractor should last indefinitely with proper repairs, since all parts are renewable and the substitution of new parts for worn ones will make the outfit as good as new. With practically all machines there comes a time when so many parts have become worn and need replacing that the cost of repairs is so great as to make it unwise to spend such an amount on an old machine, it being more profitable to discard it and buy a new one. Furthermore, it becomes increasingly difficult to obtain repair parts for any machine as years go by. Not infrequently a manufacturer goes out of business or discontinues the production of a particular machine, thus making it impossible, or at least very expensive, to obtain extra parts. It seldom pays to attempt to use badly worn machines where the farming system provides work for the labor and equipment during most of the working season, since such outfits may cause serious delays and a direct or indirect money loss equal to the cost of a new machine. This is especially true of the tractor.

The figures given would indicate an annual repair charge during the first three years of a tractor's life on New York farms of nearly

4 per cent of the first cost, but this would undoubtedly increase during the latter years of its life, as is the case with most other machines. This percentage is slightly higher than in the Corn Belt, due doubtless to the rougher ground and numerous stones which subject the tractor to many sudden jolts and jars which tend to cause breaks. It would not seem safe to expect the cost of repairs for a tractor to average less than that for other farm machines, which is a little over 4 per cent,<sup>1</sup> and it is probable that it will amount to slightly more than this. In figuring the repair costs to be charged against each day of use or acre plowed, the average annual charge has been taken as 4 per cent of the first cost, which is certainly conservative.

### THE TRACTOR'S DAY'S WORK.

#### PLOWING.

The number of acres covered per day by a single plow drawn by a tractor is usually slightly greater than that covered by the same sized horse-drawn plow. The acreage covered by two different machines, each pulling the same number of plow bottoms, often varies considerably because they travel at different speeds, are in different kinds of soil, plowing different lengths of furrows, etc. Theoretically a 14-inch plow when drawn by a tractor should cover approximately 3 acres in an ordinary working day of 10 hours, as the average plowing speed is slightly more than 2 miles per hour. This will hold true in actual practice when the plowing conditions are favorable, provided the outfit does not give trouble. That is, a 2-plow machine should plow 6 acres and a 5-plow outfit 15 acres per day, provided both travel at the average rate of speed and are kept moving. However, where trash is to be turned under which frequently clogs the plows, each plow drawn by a large tractor will cover much less ground in a day than one drawn by a small outfit, since the delays will naturally be in proportion to the number of plows pulled. A delay on account of one plow on a 2-plow outfit stops only one other plow, while on a 5-plow rig, for example, it stops 4 other plows. To illustrate: Supposing a man operating a 2-plow tractor were compelled to stop 10 times during a day for each plow in order to clear it of trash, and spent three minutes each time (which would not be unusual), the loss of time during the day would amount to a half hour for each plow, or but one hour total loss. Each plow would have done nine-tenths as much work as in plowing continuously. On the other hand, a man operating a 5-plow tractor under the same conditions would have to clear each plow the same number of times in proportion to the acreage covered, resulting in a total loss of  $2\frac{1}{2}$  hours for each plow during the day. In such case each plow would have done only three-fourths as much work as if plowing continuously.

In view of these facts it is apparent that when plowing under unfavorable conditions large gang plows do not cover as much ground per day per plow as the smaller ones. However, one man accomplishes considerably more work with the large outfits, even under such conditions.

According to the figures furnished by tractor owners in New York the area covered per day (10 net working hours) in plowing with the tractors most commonly used is  $4\frac{1}{2}$  and  $6\frac{1}{4}$  acres for the 2 and 3 plow outfits, respectively.

These acreages are considerably lower than are usually covered by the same sized outfits working under more favorable conditions, such as large, level fields, and lighter soil. The conditions existing in New York, as mentioned on page 4, tend to reduce materially the acreage covered per day with tractor-drawn plows because of the rather frequent delays caused by striking obstructions, more turning in the smaller fields, etc.

#### OTHER WORK.

The acreage covered per day at field operations other than plowing will vary, of course, with the width of the implement pulled, and this in turn will depend upon the relative draft. It is therefore impossible to give for such operations average figures which would be of value. In harrowing or disking, for example, the width of the implement that can be pulled will depend upon the adjustment of the disks or harrow teeth and the depth to which the ground is being worked (fig. 2). The nature of the soil will also have an influence. The speed of the tractor ordinarily will not be quite as great in soft ground as where the machine has a firm footing, because of the greater slippage of the wheels. On the whole, not so much time is lost on account of clogging or other obstructions when harrowing, disking, etc., as when plowing.

The approximate acreage covered in a day of 10 hours with implements of different widths can be determined easily by allowing about 2 acres per day for each foot of the implement's width where the outfit is working on soft ground. Where it has a good footing it may be safe to allow  $2\frac{1}{2}$  acres for each foot of the implement's width. The acreage covered, of course, will vary with different machines, owing to the different speeds, but the figures given are based on a speed of 2 miles per hour, with an allowance for time lost in turning and the overlapping which occurs to a slightly greater extent in most other field operations than in plowing.

By far the largest proportion of the work done by tractors is in plowing and preparing the seed bed and in belt work. While they are used for a number of odd jobs at different times, these represent an insignificant portion of the total work. Hauling, which usually occupies farm horses for several days annually, is not commonly under-

taken with the traetor, and in most cases where it has been tried it has been found less satisfactory and more expensive than horses or motor truck. Objections to the use of the traetor for hauling advanced by men who have tried it are the heavy wear and tear on both traetor and wagons on hard roads, expense on the unloaded return trip almost as great as when loaded, and difficulty in handling heavy loads on grades. Restrictions regarding the use of traetors on improved roads doubtless have considerable influence in this matter also. It



FIG. 2.—In harrowing or disking, the width of the implement that can be pulled depends in large measure upon the adjustment of disks or teeth.

is not surprising, therefore, that only about 7 per cent of New York traetor owners report doing hauling with their outfits and that on the whole it represents a very small per cent of the work done by the traetor.

#### COST OF OPERATING TRACTOR.

Probably the one point in which the prospective purchaser of a traetor will be more interested than in any other will be the cost of performing farm operations with the traetor. This cost is made up of four main factors, (1) operating expenses (including fuel, oil, and grease), (2) repairs, (3) depreciation, and (4) cost of man labor. In addition there will be some less important charges, such as interest on the investment, cost of housing, and time spent in caring for the outfit other than repair work.

When calculating cost of tractor work the mistake should not be made of omitting any of these four items, as each of them will amount to considerable per unit of work. Any other costs will be comparatively insignificant in most cases, although they should be included to obtain a strictly accurate figure.

In order to give the prospective purchaser an idea of the average cost of using a tractor, the following figures for the two sizes most commonly used in New York are presented. From the facts given it is believed that a farmer can approximate the costs for any other size in which he may be interested.

#### FUEL, OIL, AND GREASE COSTS.

Based on the figures given below for the New York farms reporting, the average cost per acre plowed for gasoline, oil, and grease is about  $99\frac{1}{2}$  cents where gasoline is used, and 49 cents where kerosene is used, with an allowance of 2 cents per acre made for gasoline used in warming up.

#### FUEL.

The average quantity of fuel consumed per acre in plowing for all tractors on New York farms reporting is about  $3\frac{1}{2}$  gallons of either gasoline or kerosene. This figure does not vary materially for the different-sized outfits, so long as each pulls its normal load. It is possible, however, to reduce the fuel consumption per acre somewhat by overloading the tractor; that is, adding one more plow bottom than the machine is intended to pull. This reduces the distance the machine must travel to plow an acre, and, consequently, results in a slight saving of fuel. The saving is not in proportion to the actual distance traveled, however, since with the overload there is much more slippage of the wheels and consequent loss of power, and the increased repair bills, and time lost per day through trouble with the tractor, usually more than offset the slight saving in fuel.

There is some slight difference in the fuel consumption between different makes of machines and also usually a slightly lower consumption where gasoline is used instead of kerosene. These differences, however, do not usually amount to a great deal, and for most purposes the figure of  $3\frac{1}{2}$  gallons of either gasoline or kerosene per acre of plowing will be as nearly accurate as any that can be used for an average.

Less difficulty is being encountered by owners of kerosene tractors in burning the lower grade of fuel than was the case a few years ago. About 75 per cent of the tractors on the New York farms reporting are operating on kerosene, and where the machines have been especially designed to burn this fuel the results are apparently very satisfactory, particularly in view of the 1918 price of kerosene as compared with gasoline, the former costing less than one-half as

much as gasoline. However, the greater ease in operating on gasoline and the somewhat greater certainty of steady operation are sufficient to cause some men to prefer this fuel to kerosene. The fuel consumption, of course, varies considerably, even with the same make of machine and under practically the same conditions when driven by different operators, as a proficient operator will be able to make such adjustments as will reduce the fuel consumption to the minimum, whereas an inefficient operator will frequently run the outfit in such a manner as to increase unduly the amount of fuel used. In this case, as in others, a prospective purchaser is not safe in assuming that he can obtain better results than the average, although of course he should endeavor to do so. In making calculations it is always best to be on the safe side.

The average price paid for gasoline by the New York tractor owners in 1917 was about 25 cents per gallon and for kerosene about 10 cents per gallon. With these prices, therefore, the fuel cost per acre for plowing with the tractor averaged about 35 cents where kerosene was used and 87½ cents where gasoline was used, not making any allowance for warming up the kerosene engine with gasoline. All kerosene tractors start and warm up on gasoline, but the quantity used for this purpose varies greatly with different makes and with different operators. The quantity of gasoline required for this purpose is in most cases less than 1 gallon per day, and the extra cost for gasoline will usually not exceed 10 cents per day, and should seldom be more than 2 cents per acre plowed.

#### LUBRICATING OIL.

The quantity of lubricating oil used per acre with different outfits showed a much greater variation than the fuel required. Some men reported using over a gallon of lubricating oil per acre, while many reported less than 1 quart per acre. The quantity used will, of course, vary somewhat with the different makes of machines, but the greatest variation will be due to the idea of the operator as to the quantity with which the engine should be supplied.

The average quantity of oil per acre used in plowing, for all tractors reported from New York, was nearly 1 quart. With oil at 40 cents per gallon (the average price paid for it), this would amount to 10 cents per acre. The kind of fuel used does not seem to make any decided difference in the quantity of lubricating oil required per acre, but the 3-plow machines appear to be slightly more economical in this respect than the 2-plow. The difference, however, is practically negligible.

#### GREASE.

The quantity of grease, or "hard oil," used also varies widely. No attempt to obtain definite figures on this point was made, but 2 cents per acre would be a reasonable figure.

## REPAIRS.

Using the figures given under "Tractor Repairs" on page 12, and under "Days used annually" on page 11, i. e., the average annual repair charge as 4 per cent of the first cost, and the days used annually as 54, the average repair charge for the 2 and 3 plow outfits of average price would be  $57\frac{1}{2}$  cents and 78 cents per day, respectively. For the average acreage covered with these rigs, the repair charge per acre would therefore be  $12\frac{3}{4}$  and  $12\frac{1}{2}$  cents, respectively.

## DEPRECIATION.

Assuming the average life of a tractor to be  $8\frac{1}{2}$  years (see p. 9), the average annual depreciation on the 2 and 3 plow outfits will be \$91.18 and \$123.54, respectively. The daily charge, therefore, based on 54 working days per year (see p. 11), will be \$1.69 and \$2.29, respectively.

The depreciation cost per acre, based on the average acreage covered by the different-sized outfits, as shown on page 13, will be  $37\frac{1}{2}$  and  $36\frac{3}{4}$  cents, respectively. From these figures it will be seen that the depreciation charge is one of the largest items which go to make up the total cost of performing work with the tractor, yet it is one which many people ignore entirely when figuring tractor costs. In this case, too, a rather long life has been assumed, which makes the depreciation somewhat lower than would be altogether safe to count upon. (See p. 10.)

## MAN LABOR.

Eighteen per cent of the New York tractor owners reporting hire operators, and in cases where the machine is operated by hired help the wages paid vary widely. Some men intrust their machines to ordinary hired hands at comparatively low wages, while others attempt to secure first-class operators and are willing to pay fairly high wages to secure thoroughly competent men.

The cost per acre for man labor will be considerably affected, of course, by the wages paid, although in many cases a high-priced operator may do enough more work per day partly to offset his higher wages, and by reducing operating and repair charges may much more than offset them. The greater reliability of the higher priced operator and the consequent certainty of having the work done when desired also has a value, but the value of this advantage can not be calculated.

To ascertain the cost per acre for man labor in plowing with a tractor, in order to round out these cost figures, the cost for man labor has been placed at \$3 per day. This is about the actual cost for operators to many farmers when cost of board, etc., is included, but is less than actual cost on a considerable number of farms. Using this

figure the cost per acre for man labor with 2 and 3 plow outfits, based on the average acreage given, would be 67 cents and 48 cents, respectively. The higher the wages paid the greater is the advantage of the larger tractor.

#### INTEREST.

The interest charge on a tractor is a fixed annual charge, and the interest cost per unit of work obviously will vary with the number of days the tractor is used, decreasing as the number of days used increases. Figuring interest at 6 per cent on the average investment (one-half the first cost) for the different-sized tractors, as shown on page 9, and assuming the average number of days used annually to be 54 (see p. 11), the average interest charge per day for the 2 and 3 plow outfits will be 43 and 58½ cents, respectively.



FIG. 3.—Small tractor drawing binder on eastern farm. While slightly more ground is covered per day by this method than by the use of horses, the tractor is of questionable value for such service, since the outfit requires two men as against one where horses are used.

The interest cost per acre, based on the average acreage covered by the different-sized rigs, would therefore be 9½ and 9¾ cents, respectively. The increased acreage plowed per day by the 3-plow rig, as compared with the 2-plow, offsets the increased interest charge due to higher price. It should be borne in mind, however, that the number of days used annually will cause a variation in the interest charge per unit of work.

#### TOTAL COST PER ACRE.

##### FOR PLOWING.

The approximate total cost for plowing an acre with a tractor under normal conditions, as calculated from the figures given in the preceding pages, would be as shown on page 20.

*Approximate cost of plowing an acre with 2 and 3 plow tractors, based on average cost of \$775 and \$1,050, respectively, and a life of 8½ years of 54 working days per year.*

Size of tractor.	Fuel.		Oil.	Grease.	Re-pairs.	Depre-ciation.	Man-labor.	Inter-est.	Total cost. <sup>a</sup>	
	Gaso-line.	Kero-sene.							Gaso-line tractor.	Kero-sene tractor.
Two-plow.....	\$0.87½	\$0.37	\$0.10	\$0.02	\$0.12½	\$0.37½	\$0.67	\$0.09½	\$2.26½	\$1.75½
Three-plow.....	.87½	.37	.10	.02	.12½	.36½	.48	.09½	2.06	1.55½

<sup>a</sup> The cost of housing the outfit and other minor overhead charges, such as taxes, insurance, etc., are not included.

#### FOR OTHER OPERATIONS.

From the figures given above it will be a comparatively easy matter to arrive at relative costs for other operations with the tractor. For all field operations the daily charges for interest, depreciation, and man labor will, of course, be about the same, but must be divided by the acreage covered by the implement used. This acreage will vary with different implements. The fuel and oil charge will be the same for a 10-hour day in other field operations as in plowing, provided the tractor is loaded to the same extent. This, however, is frequently not the case. If a comparatively light load is drawn, the fuel and oil consumption will be somewhat reduced, but not in proportion to the load. For stationary work, if the engine is working to full capacity, the fuel and oil charges will be approximately the same as for a day's work in plowing, but no grease will be used on most machines. This, however, would be only a small item.

#### ECONOMY OF TRACTOR.

From the figures given under the cost of operation it will be noted that the cost of doing plowing or other field operations with a tractor is fully as great as with horses, omitting the item of man labor. This will average lower with the tractor than where horses are used, assuming wages to be the same in each case.

The advantage of the tractor, therefore, like that of most other improved farm machines, lies not so much in the reduction of the cost of performing a unit of work as in the fact that it permits one man to do considerably more work within a given period of time. This has been true of practically all improved farm machines, even of the grain binder, which is generally considered as one of the greatest agricultural inventions of the century, which did not, contrary, perhaps, to general opinion, decrease the cost of harvesting wheat to any considerable extent, but did increase about eightfold the acreage which one man could handle. (See Department of Agriculture Bulletin 627.)

Men who hope to reduce greatly the cost of farming operations by the purchase of a tractor should bear these facts in mind, and also the fact that few tractor owners mention as an advantage reduction in the cost of performing farm work.

**J**UDGING by the experience of tractor users, it is not safe to expect any material reduction in the cost of farm operations per acre through the use of the tractor, but it is safe to expect to be able to increase the crop acreage to a very considerable extent, and, at the same time, the amount of crops which one man can raise.

Furthermore, it should be remembered that the cost of doing the work with a tractor as above outlined in most cases can not be directly compared with the cost of doing it with horses, since on farms where tractors are used a number of horses generally are retained, and any comparison, therefore, must be made between the cost of operating the farm with horses alone and the cost of operating with the tractor and a certain number of horses. Not infrequently horses stand idle while the tractor is being used for field work because not sufficient help is available to use them at the same time, and in such cases part of the cost of their maintenance must be considered when figuring the cost of farm operations, since they are as much a part of the farm power plant as is the tractor.

Neither should it be forgotten that not only should the relative expense of operation with the two methods be considered, but also the relative results. The increased crop acreage and consequent increase in incomes which the purchase of the tractor will often make possible may much more than offset a slight increase in the operating expenses of the farm.

The saving in hired help effected through use of the tractor is very frequently quite an important item in reducing the cost of farming operations. That this is quite a factor in a great many cases is indicated by the fact that, of 217 owners, 185, or 85 per cent, stated that the tractor had effected a saving in the amount of hired help necessary to operate the farms. Not all of these men furnished an estimate of the amount saved, but 57 did give such an estimate. The average saved in wages through the use of the tractor on these 57 farms amounted to \$213 annually. This would be equivalent to one man for 71 days at \$3 per day and would be quite an item on most eastern farms.

In figuring the saving which may be expected from the purchase of a tractor the advantages of having power available for various kinds of belt work should not be overlooked. On most eastern farms there are a number of jobs, such as thrashing, silo filling, shredding, etc., for which belt power is required and which it is highly desirable to have carried on promptly. Where a custom rig is depended upon for such power inconvenience, if not actual loss, is not at all uncommon, owing to delay in obtaining a rig when needed. The gas tractor makes an admirable power plant for such work, provided care is exercised to obtain one with sufficient power to meet requirements. On many farms the purchase of a tractor obviates the necessity of maintaining a stationary engine, thus partially offsetting the investment charge.

#### QUALITY OF TRACTOR WORK.

Not a few farmers when considering the purchase of a tractor hesitate because of the fear that they may not be able to do the work as satisfactorily as with horses. This applies principally to plowing. That there is little reason for this attitude is indicated by the fact that more than 50 per cent of tractor owners report that the quality of work done by the tractor is better than that done by horses, while only 6 per cent say it is poorer.

The quality of work done in plowing does not depend so much upon the tractor as upon the plow and its adjustment. Under average conditions the work done by most engine gang plows when properly adjusted is fully equal, and often superior, to the work done by either a walking or gang plow drawn by horses and operated by a skillful plowman. If a job of plowing where a tractor is used is not satisfactory it is not usually the fault of the tractor, but of the plow, or, more probably, it is due to misadjustment of the plow. Of course, in fields with obstructions, sharp angles, etc., the tractor may be responsible for poor work because of its clumsiness, but under most conditions the plow and the operator determine the quality of the work done. The tractor's part is to furnish the power to pull the plow.

This point should be kept in mind by farmers who select their tractors by visiting demonstrations of different makes of outfits. The quality of the work done by different machines should be of value in selecting a good gang plow, but it is practically worthless in determining the value of the different tractors. It is quite possible that a tractor of very inferior quality may be pulling a good gang plow, well adjusted, and doing much better work than an outfit of first-class quality which is pulling a poor plow or one that is out of adjustment.

The average depth of plowing done with tractors by the New York farmers who furnished data for this bulletin is a little over  $7\frac{1}{2}$  inches. The average depth they had previously plowed with horses was slightly less than  $6\frac{1}{2}$  inches. While this deeper plowing is ordinarily considered as indicating a better quality of work, it does not appear to have had any marked effect on the crop yields.

As to the quality of disking, or other work on plowed land, it will, of course, as with plowing, depend largely upon the implement drawn and the skill of the operator. The question of packing the soil is usually more important in connection with work on plowed land than in plowing, but that this is not a serious drawback with modern tractors in New York is indicated by the fact that 95 per cent of New York tractor owners reporting say that their tractors are satisfactory for use on plowed land.

#### THE TRACTOR OPERATOR.

Difficulty in operation is mentioned by tractor owners as the principal disadvantage of the tractor. Though any man of ordinary ability can operate and care for a gas tractor very satisfactorily after a little study and experience, it is decidedly unwise for him to undertake to gain the necessary experience by experimenting with his own machine. Experience in running stationary engines or automobiles, while of some value, is not enough. The important thing is the ability to detect trouble the minute it begins to develop and to be able to remedy it promptly instead of allowing it to run along until an expensive delay results.

Many owners report that it is extremely difficult to get hired help capable of operating a tractor satisfactorily. Where a tractor is to be so operated it is very important for the owner to understand the proper care of the outfit in order to see that it is not abused.

Usually the necessary training can be obtained rather easily without great expense. It pays to spend a few days in gaining experience under a competent instructor, and it is unwise to attempt to run a tractor without such preparation. Very often the time and expense involved in obtaining such training will be offset during the first year's operation.

Tractors are being improved and simplified so that difficulties in operation are growing less each year. One generation of well-trained and competent operators will disseminate information so that future generations probably will acquire knowledge on the subject as unconsciously, yet as thoroughly, as the average farmer's son to-day acquires his knowledge of horses.

The mistake should not be made of assuming that any boy can operate a tractor in an efficient manner; only a proficient operator can handle a tractor properly.

Some tractor manufacturers offer to give purchasers of their machines thorough instruction at a reasonable cost, often allowing this charge as part payment on a tractor purchased of them. Purchasers of farm tractors should avail themselves of the opportunities thus offered to obtain a training in the use of the particular machine they will be called upon to operate, which will go far toward insuring their success in its use.

#### RELIABILITY OF THE TRACTOR.

The reliability of a tractor depends to a very great extent upon the ability of the operator. Of more than 217 tractor owners in New York 48 per cent reported that their outfits were not disabled a single day when needed during the past season. Of the remaining 52 per cent the average number of days their tractors were out of commission when needed was  $6\frac{1}{2}$ . This average, however, did not include four men who stated that their machines were out of commission a large part of the time.

The reports of tractor owners indicate that with a careful and proficient operator, a gas tractor is a very dependable source of power. Occasional slight delays probably will be encountered, but serious ones will be exceptional, whereas with a careless or incompetent operator expensive delays are apt to be frequent.

Of the tractors owned by New York farmers reporting, about 82 per cent are operated by the owner or some member of his family, the best results usually being obtained by this class of operators. Twenty-eight per cent of New York owners reported no time lost in the field on account of trouble with the outfit. This probably means that the time lost was not worth mentioning. Most men do not consider it trouble so long as they know at once the cause of stoppage or other irregularity in the engine's operation, and are able to remedy it promptly. The average time lost per day by the 72 per cent reporting trouble is a little less than one hour.

#### DISPLACEMENT OF HORSES.

Many men expect the purchase of a tractor to enable them to do away very largely with the use of horses for farm work. The tractor has not displaced horses to the extent commonly expected. Its greatest advantage, as before mentioned, has been in the fact that it does the heavy work quickly and thus completes it within the proper season, since it places at the farmer's command a large amount of untiring power when needed.

The tractor does displace horses to some extent, but only in about two-thirds of the cases where it is used on the same number of acres as were previously farmed. In these instances, the horses displaced average about two and one-half.

Considering all farms where tractors have been purchased, regardless of whether or not the acreage was increased after the purchase of the tractor, the displacement of horses is rather negligible, since on 252 farms where tractors were purchased the total work stock (including both mares and horses) owned when the tractor was purchased amounted to 1,321, while the total for these farms after the purchase of the tractor was 1,018, or a reduction of only 303 head, an average displacement of 1.2 horses per tractor, or less than half the number above mentioned, where the acreage remained the same.

New York farms, on account of the great diversification of crops raised, do not offer the most favorable conditions for the displacement of horses by the tractor, since there is much work on these farms for which the machines can not be used profitably. For considerable cultivating and light hauling the tractor is not as economical or as satisfactory as horses. While on some of the larger farms a motor-driven cultivator in addition to the tractor may help considerably in reducing the number of necessary horses, on a great many of these farms the acreage of cultivated crops is scarcely sufficient to warrant investing in one of these outfits.

The decrease in the work stock laid off after the purchase of the tractor on New York farms is almost equally divided between work horses and mares. While it is frequently supposed that the use of a tractor will increase the chances of raising more and healthier colts, hence that a large per cent of the work stock on farms after the purchase of a tractor would be brood mares, the reports received from New York farmers do not bear out this theory, since the brood mares kept before the purchase of the tractor represent 23 per cent of the total work stock, and after the tractor was bought represented but 24 per cent, a gain of only 1 per cent.

#### TRACTOR CUSTOM WORK.

Many tractor owners in New York purchased their outfits with the idea of using them for custom work, while others got them for use on their own farms only and undertook custom work at the request of neighbors, or because it seemed to offer an opportunity for the tractor to help pay for itself.

The use of a tractor at custom work for field operations seems a rather reliable indication that the home farm is not large enough to utilize a tractor economically. This conclusion is borne out by the fact that the average size of the farms owned by men who use their tractors for custom work is slightly less than for the farms where the tractor is not so used. An efficient farm should be large enough to keep both labor and equipment employed during practically the entire working season. Of course, in the fall, after the work on the home farm is completed, it may be desirable to use the tractor for

custom work provided an adequate return can be obtained. This, of course, means that most of the custom work will be stationary operations, like thrashing, shredding fodder, and shelling corn, which can be done after the weather is unfit for field operations.

However, there seems some doubt as to whether it pays as a general rule to use the tractor for custom work even under these conditions. Of the New York tractor owners who have used their machines for custom work, about one-third stated that it had not paid them. It should be noted also that comparatively few farmers consider their entire expenses when calculating the profits from this source. Most of them ignore depreciation charges, and include only fuel, oil, labor, and such repairs as may be required during the time the outfit is used. Under these conditions it not infrequently happens that a tractor owner does custom work at an actual loss, or at any rate at no real profit when all expenses are considered.

On the whole it is preferable that the machine be kept busy on the home farm during as much of the working season as practicable, so that the owner may derive the maximum profit from its use. Certainly a tractor owner is not justified in neglecting his own work to accept employment on a neighbor's farm at the rates usually paid, although this is not an uncommon occurrence. A little ready cash seems to blind some men to their own best interests and to the ultimate profit which should be made through the use of their machines at their own work. For the 42 per cent of New York tractor owners reporting custom work, the average number of days the outfit was used annually for this purpose was 24.

#### EFFECT ON CROP YIELDS.

The reports of New York tractor owners were studied to ascertain what effect the tractor has had on crop yields. The answers to the questions which were asked on this point indicate that although increases are more common than decreases, they are not sufficiently frequent to warrant a farmer in attaching too much importance to this feature when considering the purchase of a tractor. The principal reason for increases in yields was timeliness in having the work done, although deeper and more thorough preparation of the seed bed was mentioned in several cases. Decreases were usually credited to the packing of the soil when damp, and to delays in getting work done because of trouble with the outfit. By far the largest percentage of owners, however, report no noticeable effect in either direction which can be attributed to the tractor.

Although the depth of plowing done with the tractor averages about 1 inch greater than that done with horses, this seems, from the reports, to have had a rather negligible effect on yields. This is perhaps somewhat contrary to what is generally expected, but is doubt-

less accounted for by the fact that deep plowing alone does not necessarily increase the yields, other good farming methods and practices being required in connection therewith in order to make it profitable. Furthermore, it may be that in these cases the tractor has not been in use long enough to make apparent the full beneficial effect of deep plowing.

#### TRACTOR EQUIPMENT.

During the past few years the farm tractor has developed more rapidly than has the field equipment for use with it, with the exception of gang plows. On many farms where tractors are used no special equipment other than plows is bought, other operations for which the tractor is used being performed with the ordinary machines designed for use with horses.

It is obviously impossible to obtain maximum results with a tractor when it is used with implements designed primarily for use with horses, and the objection of many tractor owners that the tractor can not be used with profit for certain types of field work will probably cease to hold good with the development of special machinery for use with the tractor. There is considerable activity at present in the development of implements and attachments designed especially for use with the tractor. Many of these will doubtless increase its value for farm work, making it practicable and economical for many field operations where its use is now both impracticable and uneconomical. It is for the purpose of doing work of the nature last mentioned that more horses are often kept after the purchase of the tractor than would be necessary if the tractor could do the work. With the development of special machinery as above outlined, it seems probable that a higher percentage of work stock will be displaced where the tractor is used.



**T**HE NEXT GREAT FACTOR to enlist for the betterment of Agriculture and rural life in this Nation is the business man of the town and the city. He has not always been alive to his obligations. He has contented himself, in too many instances, with plans to secure profit in agricultural trade, instead of sympathetically and eagerly planning constructive assistance. This duty, pressing in peace time, is of the most urgent and impelling character in this crisis; and I appeal to the bankers and business men to see that they omit no effort to familiarize themselves with the agencies serving to aid the farmers and to promote wise plans to secure the necessary results.

D. F. HOUSTON,  
Secretary of Agriculture.

**I**N THE INTEREST of our national development at all times and in the interest of war efficiency just now our agriculture must be well maintained. It should be remembered that the agricultural unit is a small unit. There are six million farms in this country, each an individual unit. It is to the interest of persons who do not live on farms, even more than to the interest of those who do live on farms, that production shall be kept up. This means that all people, not farmers alone, but those who live in cities as well as the farmers, are interested in experimental and educational activities along agricultural lines as conducted by the Federal Government and the States. These efforts should be liberally supported.

R. A. PEARSON,  
Assistant Secretary of Agriculture.

**I**N A TIME LIKE THIS no man has a moral right, whatever his fortune may be, to employ another man to render any service of mere comfort or convenience. When the finest young men of the United States are in France digging ditches, sawing lumber, laying rails, and playing with death, and when the finest young women of the United States are scrubbing floors in hospitals, it is a sin that almost approaches the unpardonable offense against civilization for any man or woman in the United States to engage in a wasteful or unnecessary service.

CLARENCE OUSLEY,  
Assistant Secretary of Agriculture.



## TO THE PATRIOTS ON THE FARMS.

You are asked to undertake another offensive—to go "over the top" this fall for a great harvest of wheat in 1919. I need give only a few figures and facts to impress you with the increasing and urgent need of our people, our armies, the allied peoples and their armies for large supplies of American wheat.

Our reserve supply or carry-over from the 1917 crop is practically exhausted and is the smallest on record. The need of building up reserves of wheat is evident. Although this country produced a small crop of this grain in 1917, the total exports of wheat in excess of imports, including flour in terms of wheat, amounted to approximately 100,000,000 bushels for the year ending June 30, 1918. This is in comparison with 178,000,000 bushels exported in 1917, 236,000,000 bushels in 1916, and 331,000,000 bushels in 1915. It was possible for the United States to export wheat in large quantities in 1915 and 1916 only because of the large wheat crops of 1912-13-14-15, which gave this country an accumulation of stocks of this grain. Both the 1916 and 1917 crops were smaller than any crops since 1911 and besides this there was a greater demand for seed wheat and an increased population to be fed.

Moreover, it must be borne in mind that the carry-over in all the ten importing countries in Europe was practically exhausted this year before the new harvest; that the normal requirements of the exporting countries are increasing instead of diminishing; that some losses in storage and transit may be expected to continue; and that it is highly desirable that a surplus should be accumulated as insurance against partial crop failure next year.

You have been asked to sow to winter wheat this fall not less than 45,000,000 acres—an increase of 7 per cent over last year's sowing—and the department has suggested that an even greater area, 47,500,000 acres, is desirable. The increased planting asked of each State has been carefully determined with regard to its local conditions and its reasonable capabilities. Your county agent can tell you the quota assigned to your State and you can apply the responsibility to your case.

You have occupied and do occupy the first line trenches of the food army. You have to fight difficulties, too. I am not unmindful of these. In the Department of Agriculture we consider them daily, and daily we give our best efforts to help you meet them. You know of the difficulties in your community, but I know of them in many communities of many States, and so seriously do they impress me that I might almost consider them insurmountable had not American farmers last year, and again this year, revealed the true American fighting spirit and ability to meet serious situations. They will not let the war fail because of deficient food production.

Let us sow liberally for a big harvest in 1919. It has been called the Liberty Wheat Harvest. We all hope it will be. But let us undertake the task with the determination that we will sweat our blood for many more if need be before we yield one measure of our freedom to a Prussian domination. Let us fight in the furrows.



*Secretary of Agriculture.*

THE FARMERS OF THIS COUNTRY are as efficient as any other farmers in the world. They do not produce more per acre than the farmers in Europe. It is not necessary that they should do so. It would perhaps be bad economy for them to attempt it. But they do produce by two to three or four times more per man, per unit of labor and capital, than the farmers of any European country. They are more alert and use more labor-saving devices than any other farmers in the world. And their response to the demands of the present emergency has been in every way remarkable. Last spring their planting exceeded by 12,000,000 acres the largest planting of any previous year, and the yields from the crops were record-breaking yields. In the fall of 1917 a wheat acreage of 42,170,000 was planted, which was 1,000,000 larger than for any preceding year, 3,000,000 greater than the next largest, and 7,000,000 greater than the preceding five-year average.

But I ought to say to you that it is not only necessary that these achievements should be repeated, but that they should be exceeded. I know what this advice involves. It involves not only labor, but sacrifice; the painstaking application of every bit of scientific knowledge and every tested practice that is available. It means the utmost economy, even to the point where the pinch comes. It means the kind of concentration and self-sacrifice which is involved in the field of battle itself, where the object always looms greater than the individual. And yet the Government will help, and help in every way that is possible.—*From President Wilson's Message to the Farmers' Conference at Urbana, Ill., January 31, 1918.*